

PATENT CLAIMS

1. An arrangement for determining the penetration depth when putting in place supporting elements into a water bed, characterised by a pressure sensor (7) for measuring the water pressure which is fastenable to the supporting element (2) or to a device (1) connected to the supporting element (2), by a device (12 to 15) for transmitting the readings (11) supplied by the pressure sensor (7) and by an evaluation unit (16) for determining the reading differences which occur during the sinking of the pressure sensor (7) on penetration of the supporting element (2) into the water bed (5).

2. An arrangement according to claim 1, characterised in that the pressure sensor (7) supplies electrical signals (11) as readings and that these signals (11) or signals gained by conversion are transmitted to the evaluation unit (16) via an electrical signal lead (15).

3. An arrangement according to claim 1 or 2, characterised in that the evaluation unit (16) comprises a computer which automatically acquires and stores the readings.

4. An arrangement according to claim 3, characterised in that the computer constantly computes and displays the penetration depth (10) from the differences in readings.

5. An arrangement according to one of claims 1 to 4, characterised in that the pressure sensor (7) is suitable for measuring absolute pressure in the order of 200 bar and has a measuring accuracy in the order of 1 mbar.

6. An arrangement according to one of claims 2 to 5, characterised in that the signal of the pressure sensor (7) consists of an analog electrical quantity, preferably a current (11) which is converted via an analog to digital converter (12)

into a digital signal and is transmitted to the evaluation unit (16).

7. An arrangement according to claim 6, characterised in that between the pressure sensor (7) and the analog to digital converter (12) there is connected an electronic subtractor (13) and an amplifier (14), by which means a preselectable part measuring range may be expanded over the whole conversion range of the analog to digital converter (12).

8. An arrangement according to one of claims 2 to 5, characterised in that the signal of the pressure sensor (7) is transmitted to the evaluation unit (16) via a digital serial interface (22).

9. An arrangement according to one of claims 2 to 5, characterised in that the pressure sensor (7) supplies a pressure dependent frequency signal (23) and a temperature dependent frequency signal (24) and that the frequency signals (23, 24) are digitalized via two frequency-digital transducers (25, 26) and the two digital signals are transmitted to the evaluation unit (16).

10. An arrangement according to one of claims 2 to 7, characterised in that the pressure sensor (7) is fastened to pile hammer (1) serving to pile-drive piles (2) into the water floor (5) and that the supply lines (3) of the pile hammer (1) also comprises the signal lead (15) of the pressure sensor (7).

11. An arrangement according to claim 10, characterised in that a computer provided for the monitoring and control of the pile hammer (1) also serves the acquisition, storage and evaluation of the readings of the pressure sensor (7).

12. An arrangement according to claim 11, characterised in that the computer also registers the number of pile drives and computes the energy sum used for this.

13. A method for determining the penetration depth when putting

in place supporting elements (2) into a water bed (5), using a pressure sensor (7) suitable for measuring water pressure and fastened underwater to a supporting element (2) or to a device connected to the supporting element (2), characterised by the subsequent method steps:

- before the beginning or during the putting in place of a supporting element, a first reading of the pressure sensor is taken and is kept as a reference value;
- after consuming a certain amount of energy for the putting in place of the supporting element (2) or after the completion of the time interval required for this, a further reading of the pressure sensor (7) is taken and retained,
- from the difference of the preceding and further readings, the penetration depth (10) achieved by the intermediate putting in place is calculated, preferably by multiplication of the difference by a suitable calibration factor;
- in the case that the desired penetration depth is not yet sufficient, the method steps are repeated from the second method step.

14. A method according to claim 13, characterised in that for improving the linearity and accuracy of the conversion function of pressure into distance, a tidal compensation and/or a gravitational acceleration compensation and/or a depth dependent density change of the water are taken into account.

15. A method according to claim 13 or 14, characterised in that during the measuring interval, further data is extracted and retained from the device (1) for putting in place the supporting element (2), particularly data for determining the required amount of energy for putting in place the supporting element (2).

16. A method according to one of claims 13 to 15, characterised in that for each retained reading, a point in time is also registered.

17. A method according to one of claims 13 to 16, characterised in that the penetration depths (10) calculated from the readings are represented on a diagram.

18. A method according to one of claims 13 to 17, characterised in that before the beginning of the determination of the penetration depth (10) the reading (11) of the pressure sensor (7) is reduced to almost zero by way of an electronic subtractor (13) and the residual value (17) is amplified by a predjustable multiplication factor (18) by way of an amplifier (14), wherein the size of the multiplication factor (18) is preselected such that the amplified residual value (19), with the maximum expected penetration depth (10), does not exceed the highest analog value which can be processed by a subsequently connected analog to digital converter (12).

19. A method according to claim 18, characterised in that the reduction of the reading of the pressure sensor (7) by way of the subtractor (13) is automatically effected before the beginning of the determination of the penetration depth (10).

20. A method according to one of claims 13 to 17, characterised in that the reading (11) of the pressure sensor (7) is digitalized by way of a highly accurate analog to digital converter (21) with a digital resolution of more than 12 bits.

21. A method according to one of claims 13 to 17, characterised in that the pressure sensor (7) is provided with a digital serial interface (22) which has a resolution of up to 0.005 ppm over a range of 3000 PSI.

22. A method according to one of claims 13 to 17, characterised in that the reading (11) of the pressure sensor (7) is transmitted by way of a first frequency signal (23) and the reading of a temperature sensor is transmitted by way of a second frequency signal (24).

23. The use of a pressure sensor (7) suitable for measuring water pressure for determining the penetration depth (10) from

the pressure differences arising when putting in place supporting elements (2) into a water bed (5), particularly by way of a method according to one of claims 13 to 22.